

# Government Reform Committee Hearing

## Climate Change: Understanding the Degree of the Problem

July 20, 2006

Jay Gulledge, PhD

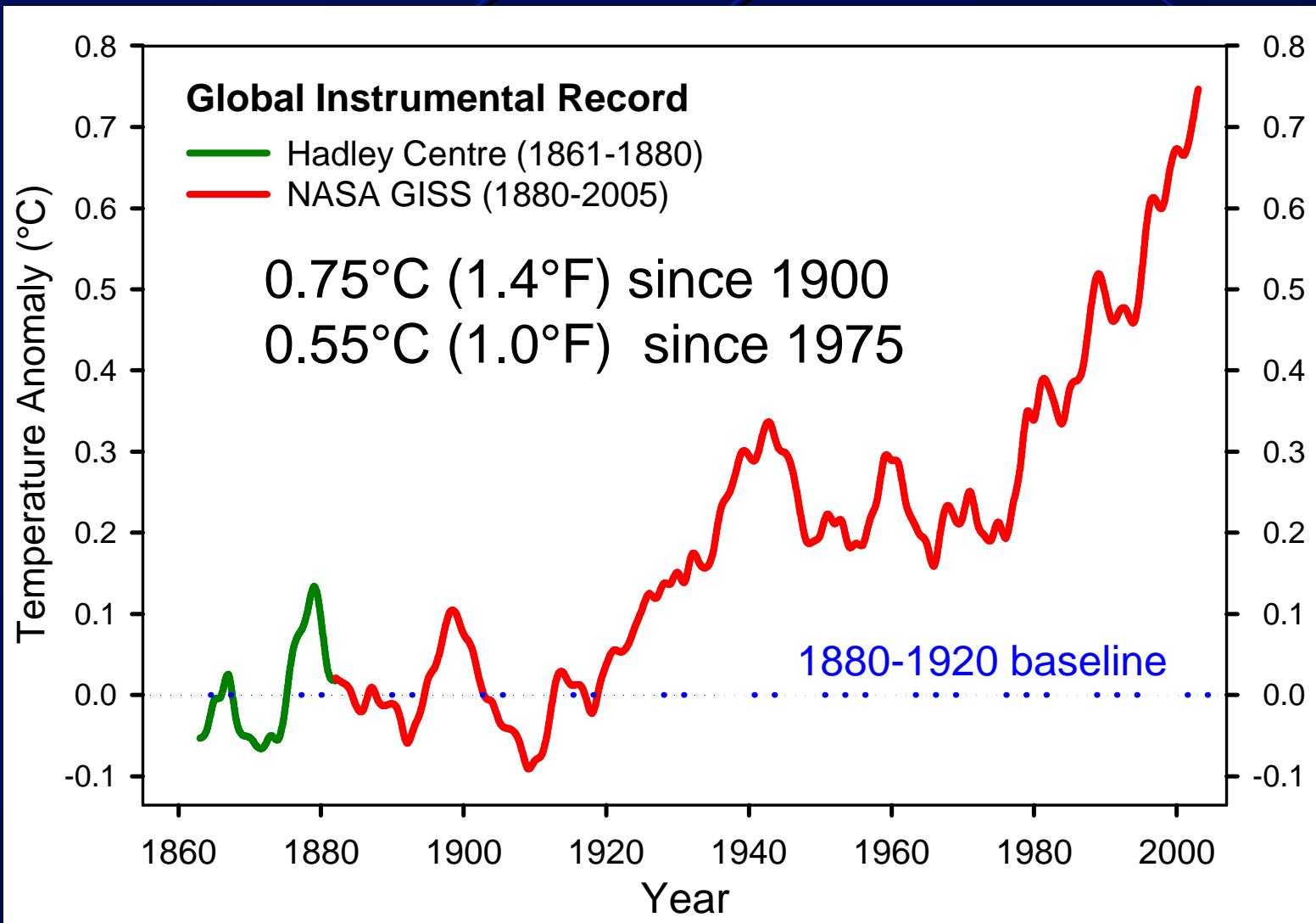
Senior Research Fellow

Pew Center on Global Climate Change

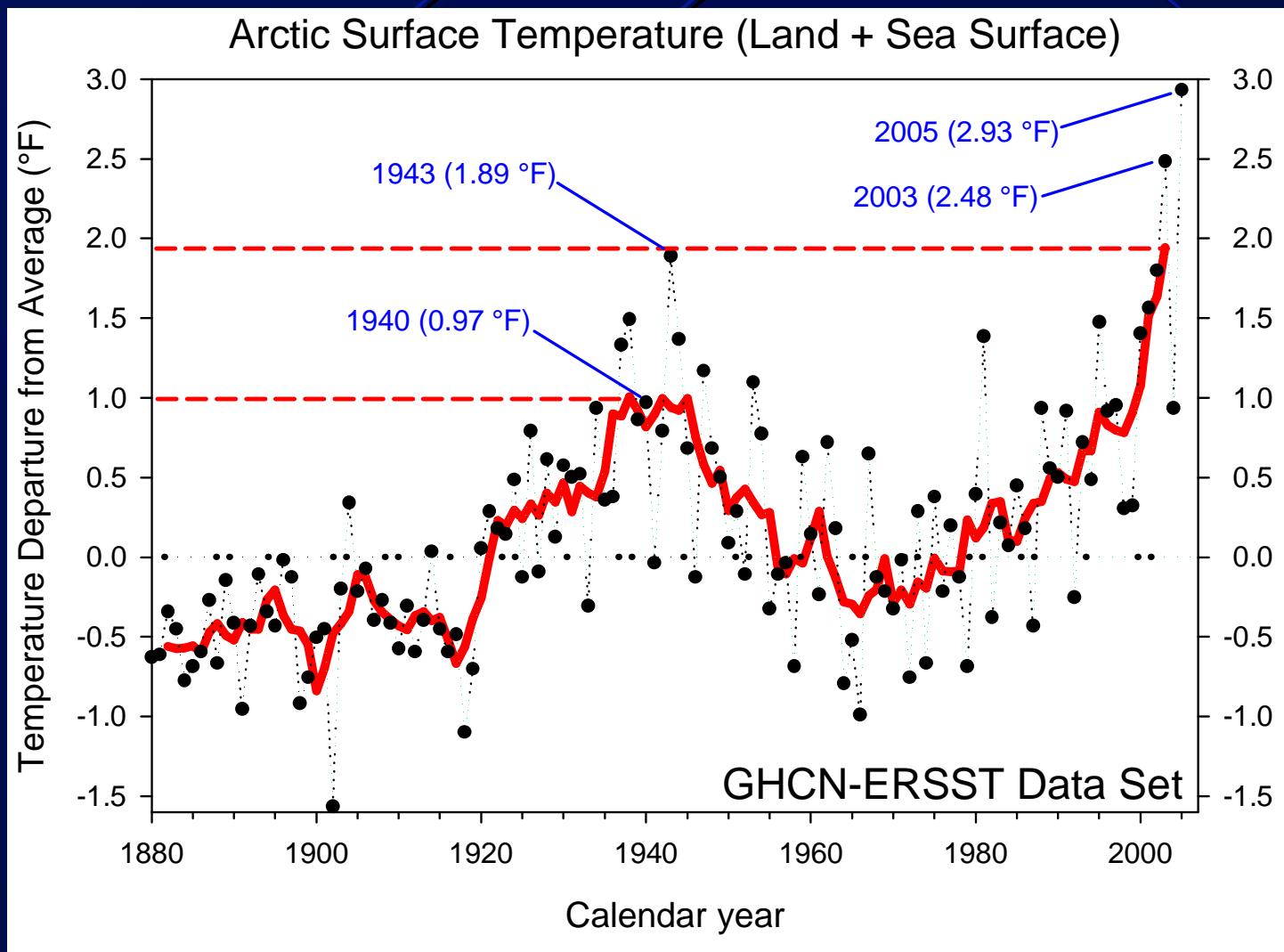
# Scientific Progress

- Landmark progress in climate science
  - 1. Reduced uncertainties
  - 2. Observed changes in the climate

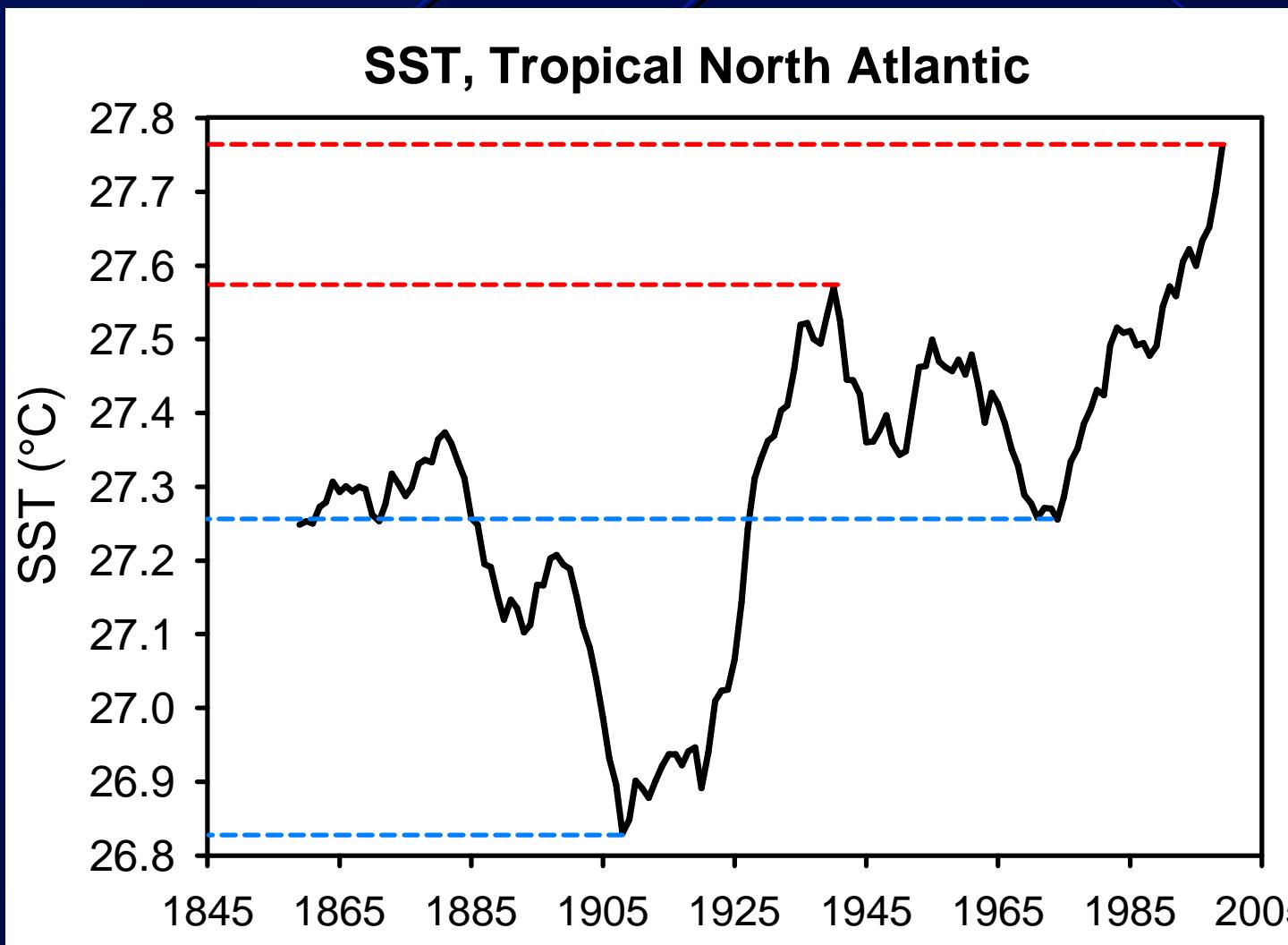
# OBSERVATION: Global surface warming



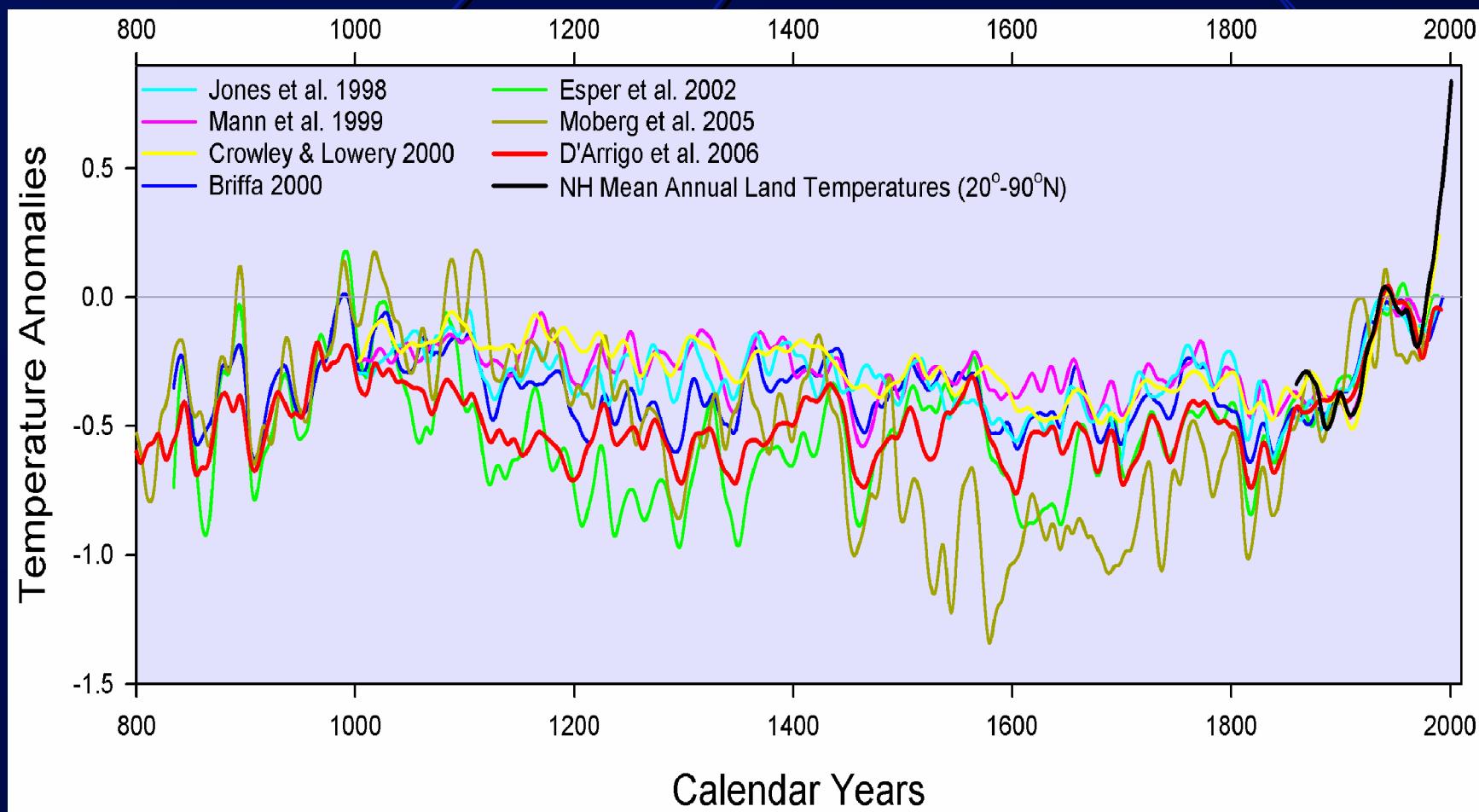
# OBSERVATION: Arctic surface warming



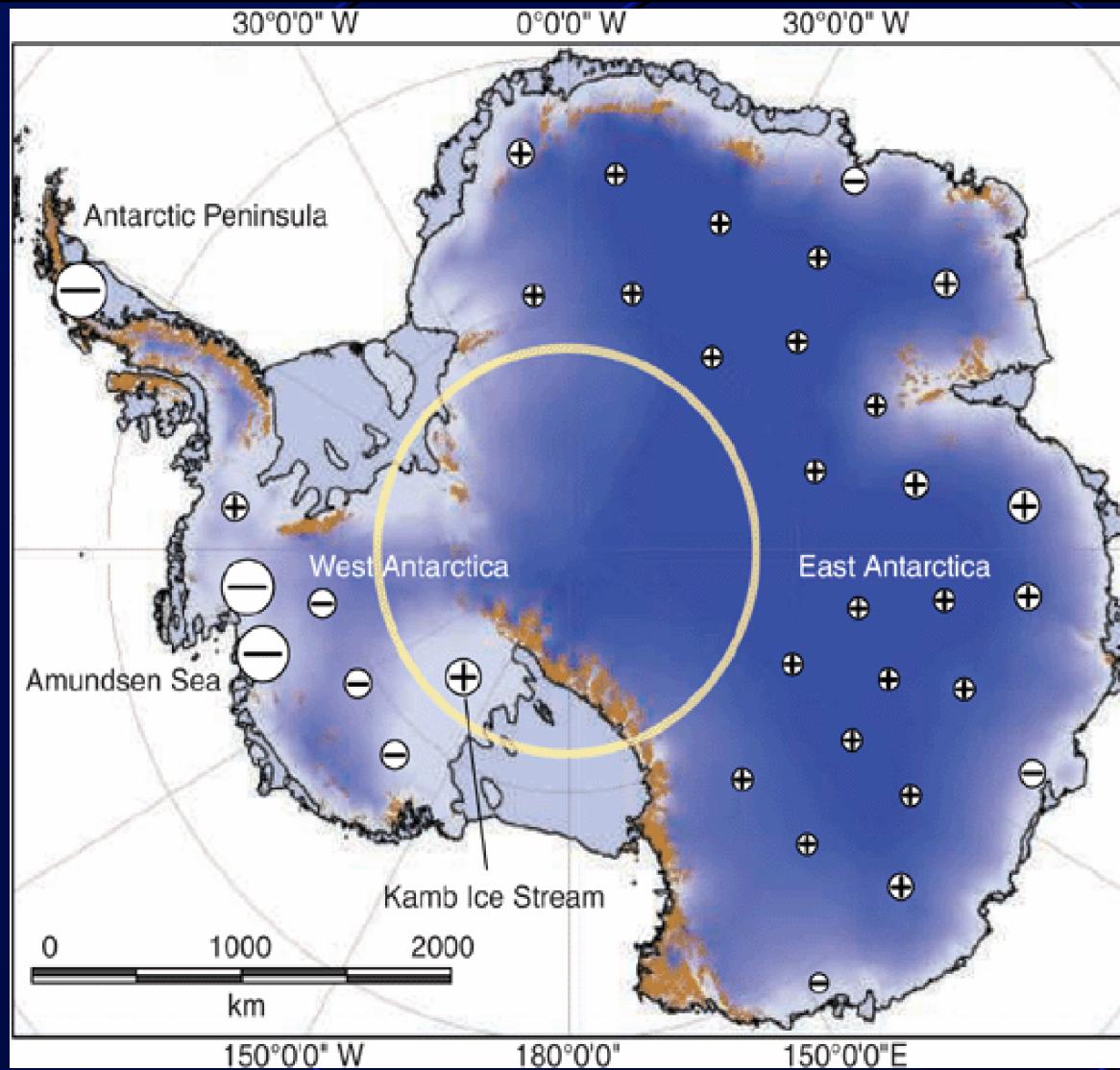
# OBSERVATION: Sea Surface Temperature



# Climate Sensitivity

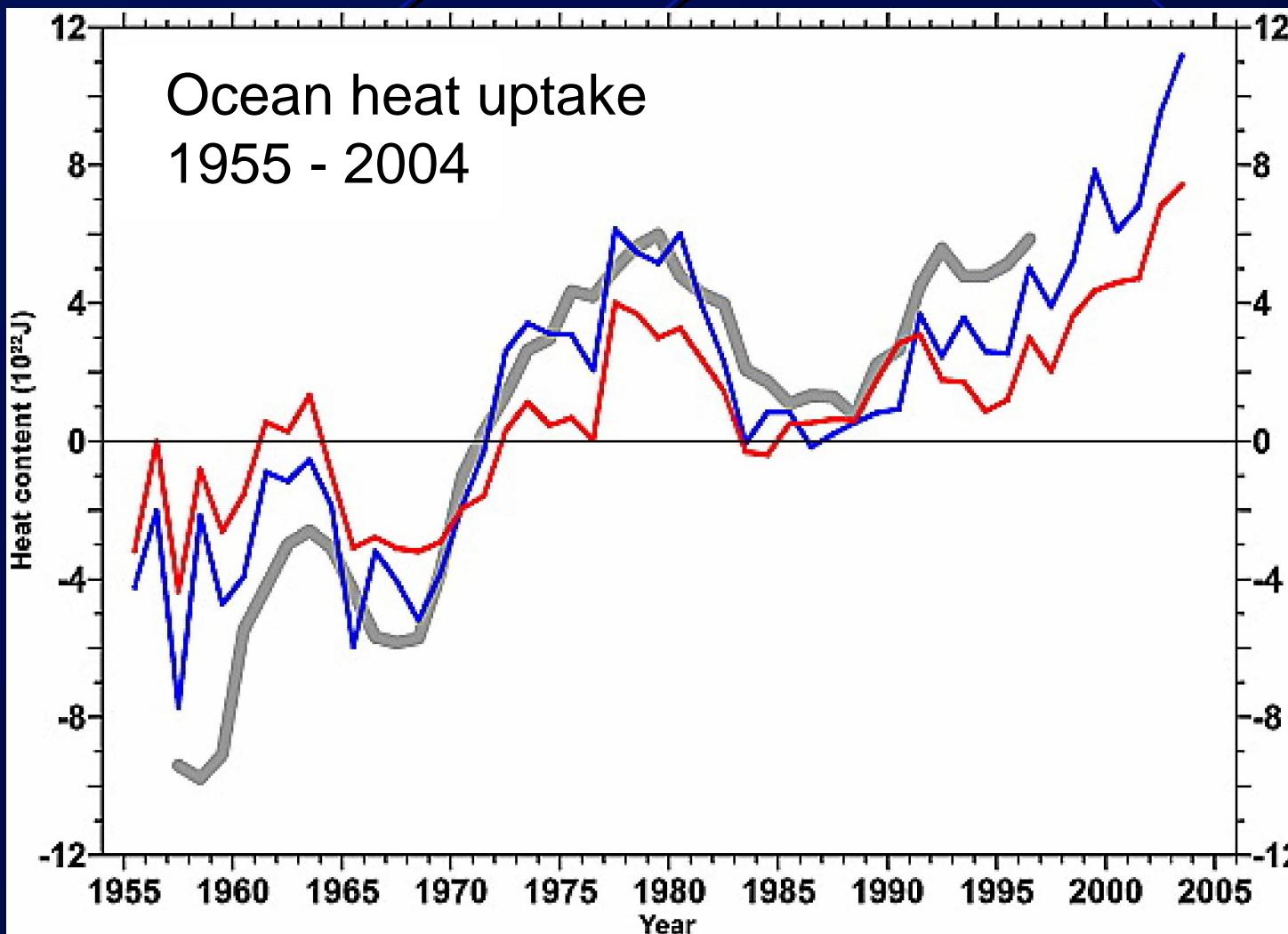


# Intensified Glacier Water Cycle



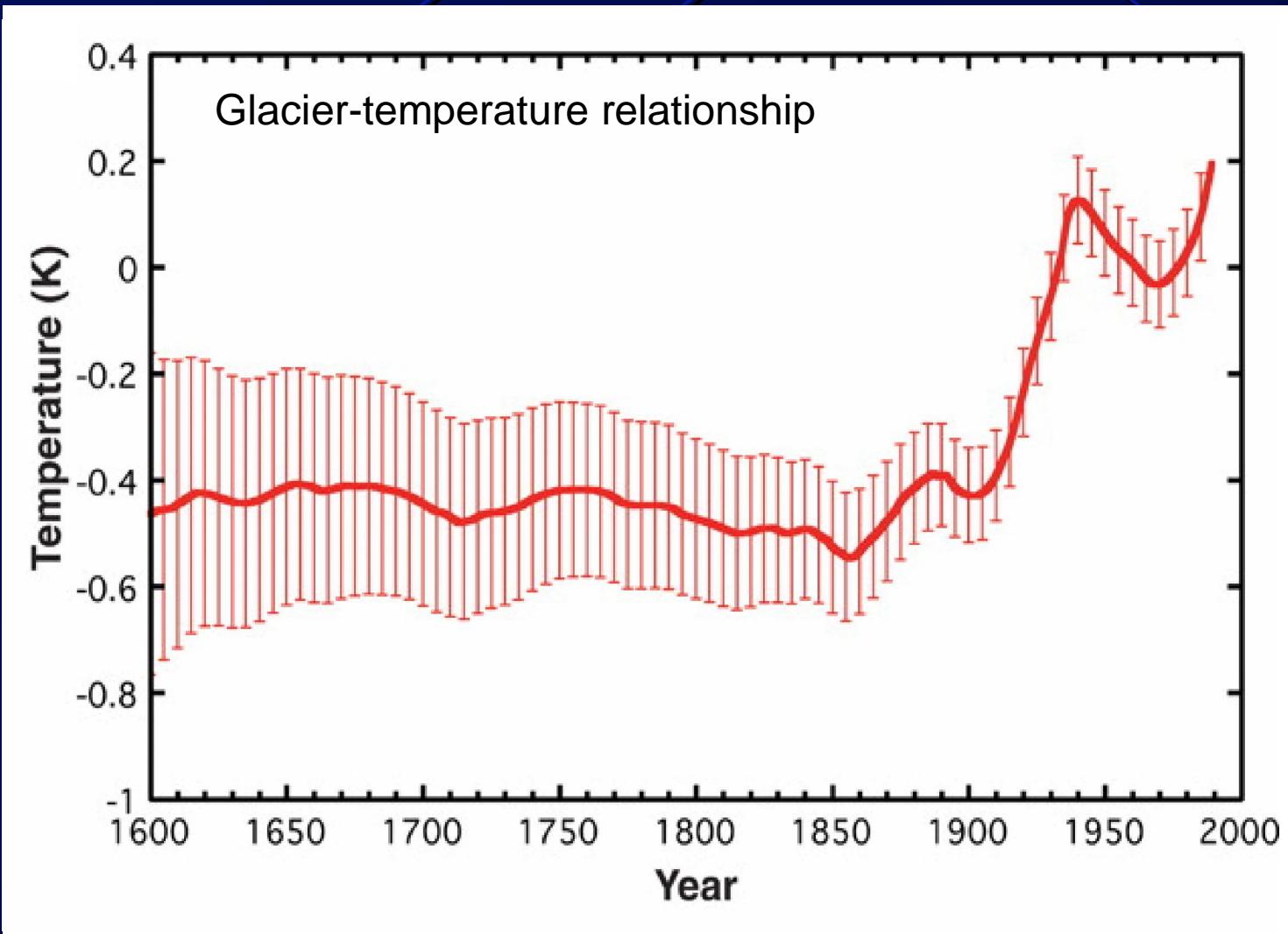
Vaughan 2005, Science 308: 1877

# Observation: Ocean heat content



Levitus 2005, GRL 32: L02604

# Observation: Mountain Glacier Loss



Oerlemans 2005, Science 308: 675

# Observation: Polar Ice Loss

## Arctic sea ice

- Rapid, accelerating loss
  - Record low in 2005 (20% lower than 1979)
  - Loss is accelerating
  - Arctic Ocean may be ice free during summer by 2100
  - Likely not ice free for at least 1 million years
- (Overpeck 2005, EOS 86:309)

### Arctic ice declines



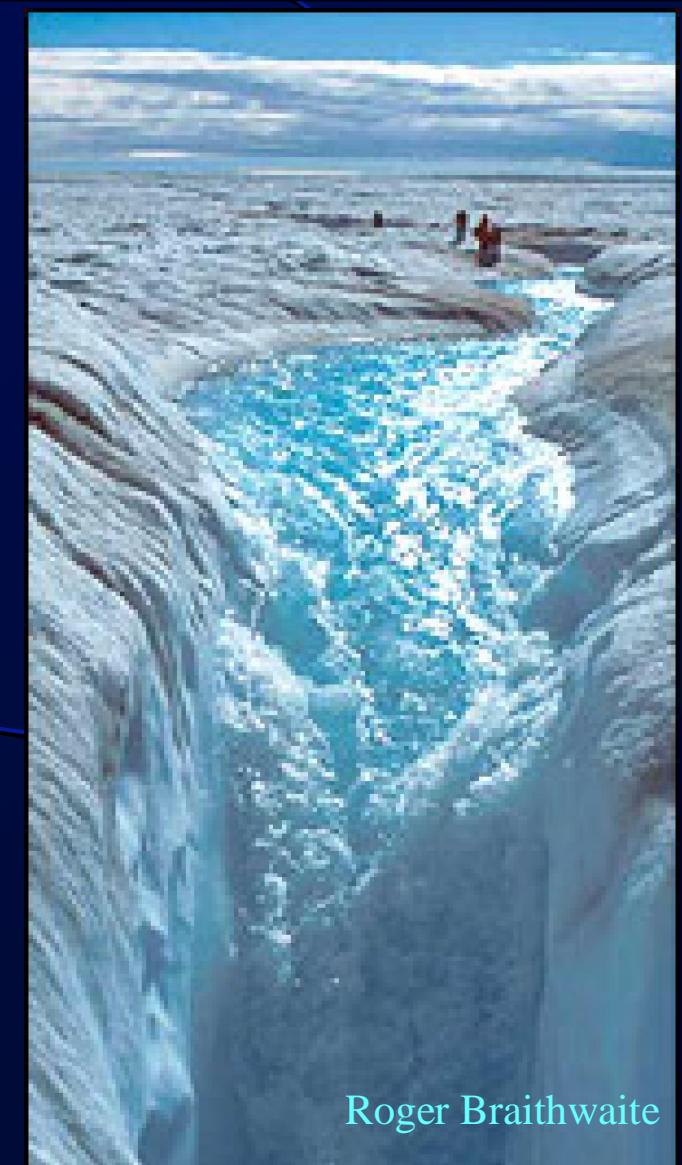
CHARLES ATKINS / Anchorage Daily News

# Observation: Polar Ice Loss

## Greenland ice sheet

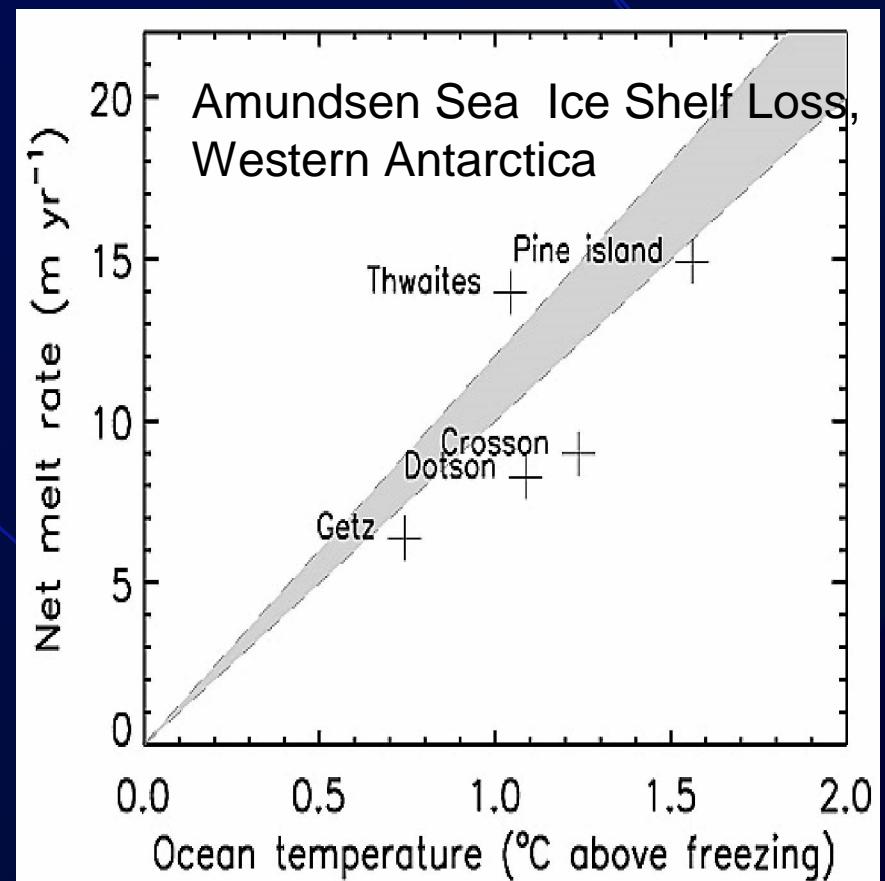
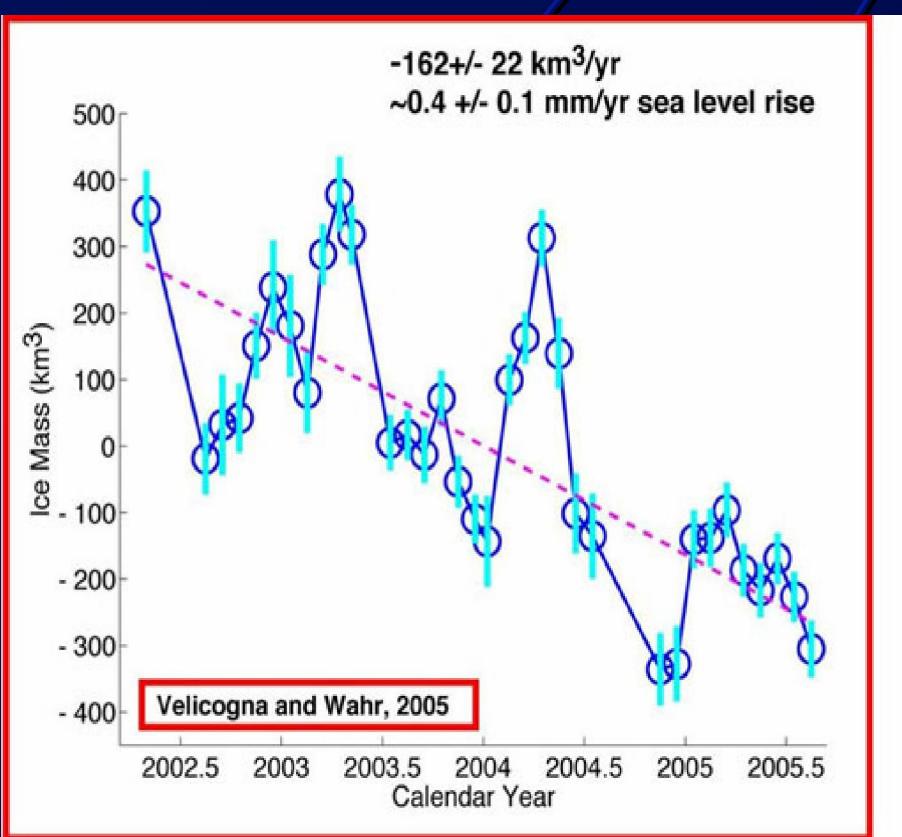
(Rignot 2006, Science 311: 986)

- Net ice loss
- Ice loss is accelerating
  - partly from melting
  - partly from ice flow
- Losing ice faster than previously estimated



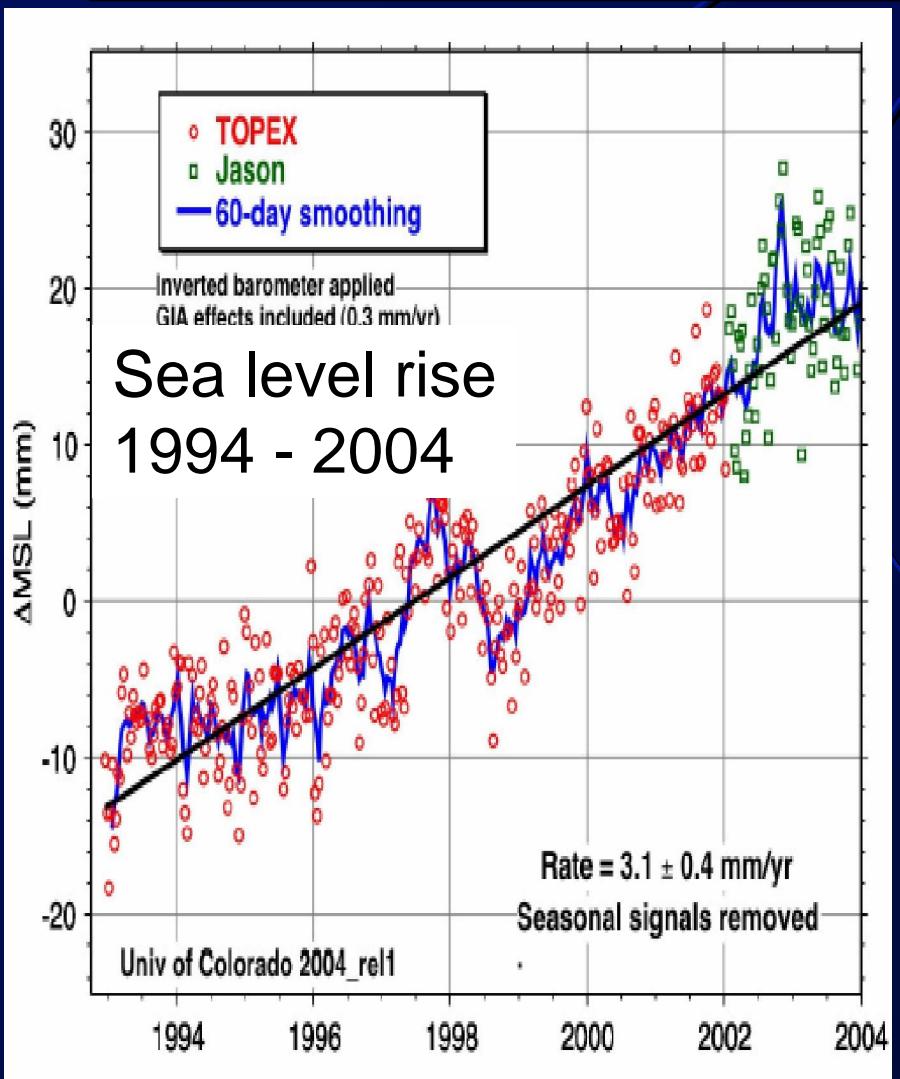
Roger Braithwaite

# Observation: Polar Ice Loss



Shepherd 2004, GRL: L021106

# Observation: Global Sea Level Rise



Nerem 2004, Rev. Geoph. 42:RG000139

- 20<sup>th</sup> Century SLR **1.8 mm**
- Total SLR from satellite altimeters: **3.1 mm**
- Small glaciers: 0.5
- Ice sheets: 0.97
- Thermal SLR: 1.6
- **TOTAL:** **3.07 mm**

# Scientific Progress

Landmark progress in climate change

## Reduced uncertainties

- Warming is truly global (even Antarctica)
- Warming has reached historic proportions
- Glacier water cycle intensification (global)
- Ocean known to be gaining heat (global)
- Sea-level rise has accelerated (global)

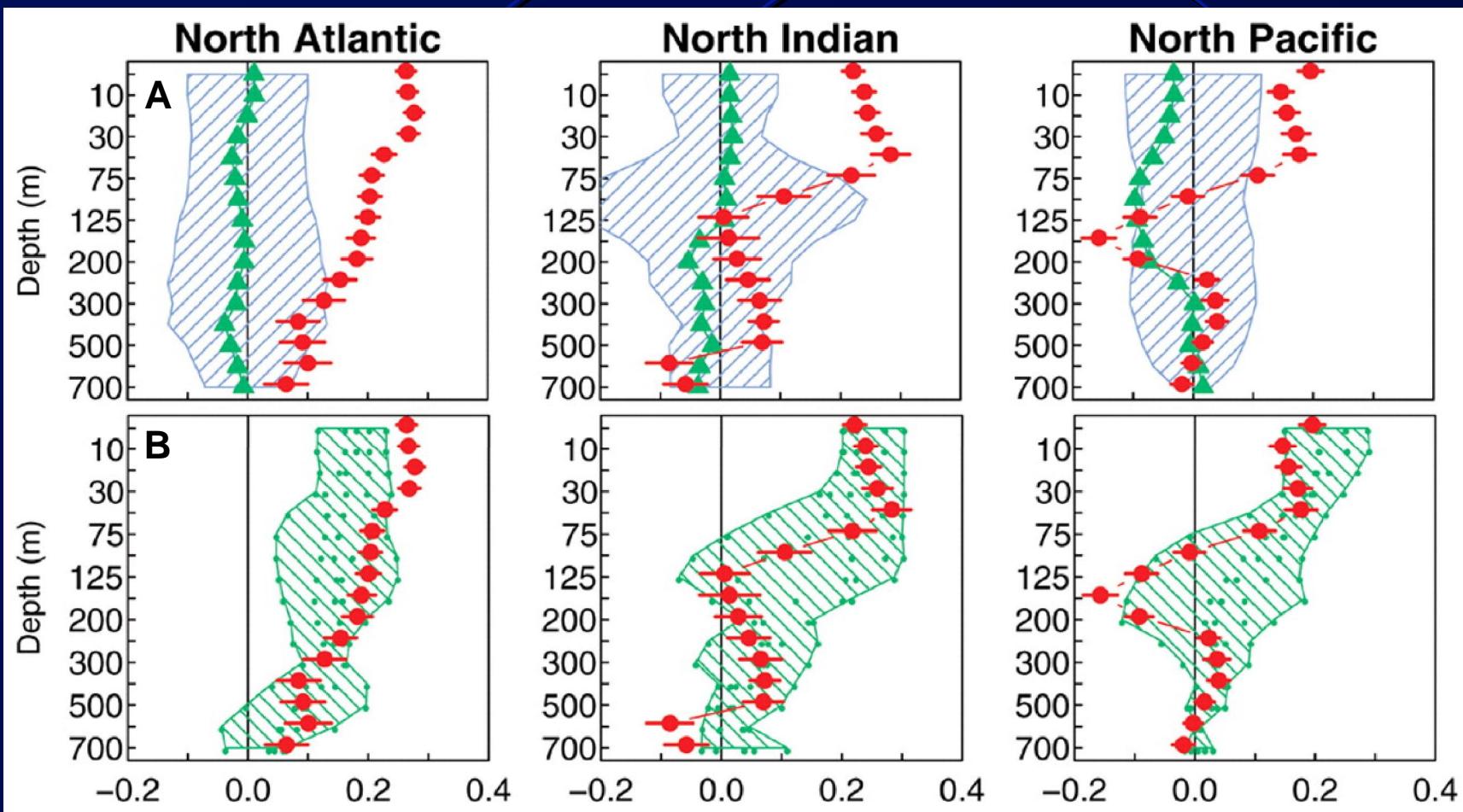
# Scientific Progress

## Landmark progress in climate change

### Observed changes in the climate

- Global glacier loss is accelerating
- Arctic Ocean heading toward ice-free conditions
- Changes are faster than predicted
- Observations demonstrate high climate sensitivity

# Observation: Ocean heat content



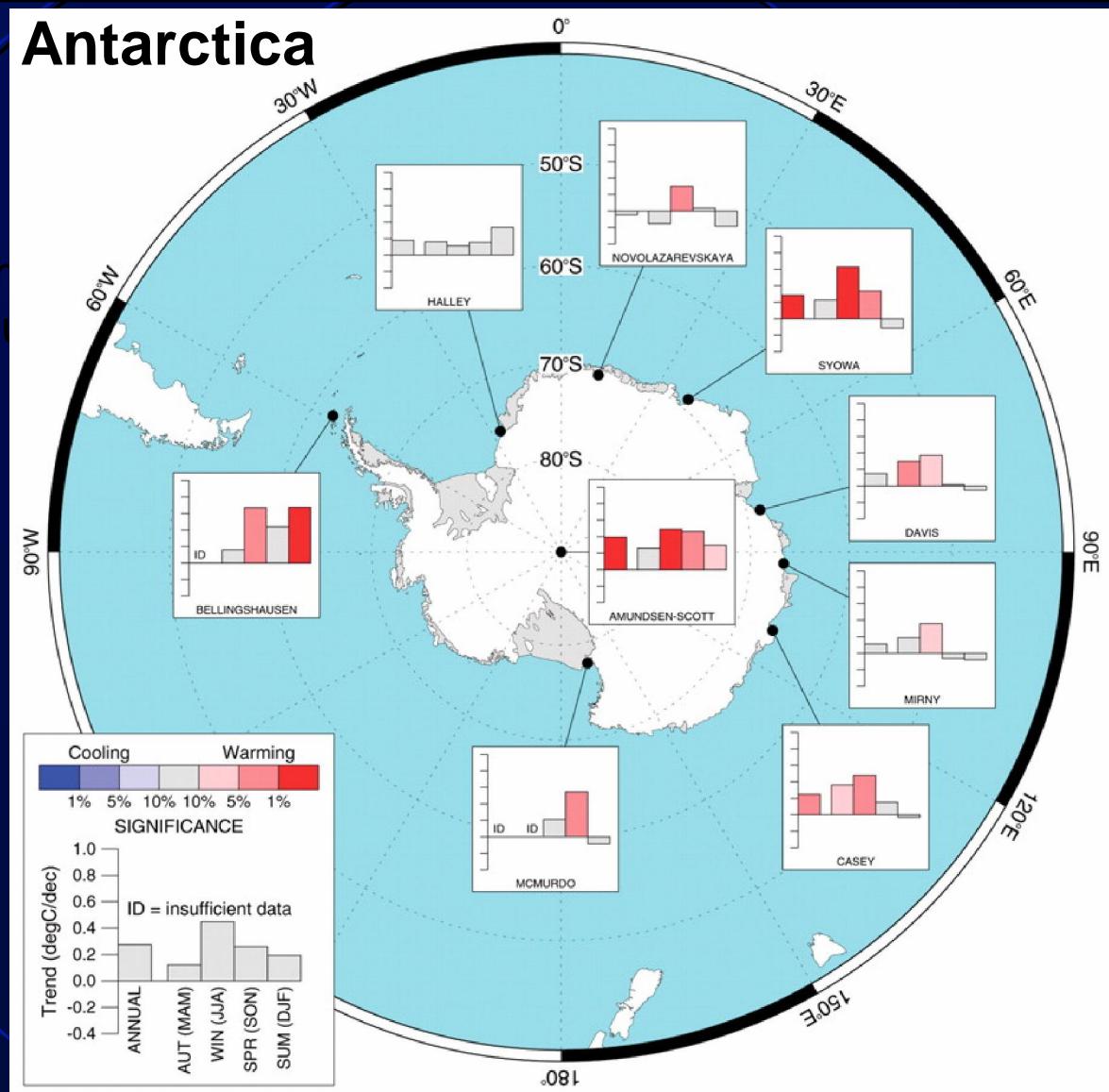
A. Natural factors only

Barnett 2005, Science 309:284

B. Natural + Human factors

# Observation : Antarctic atmosphere warming

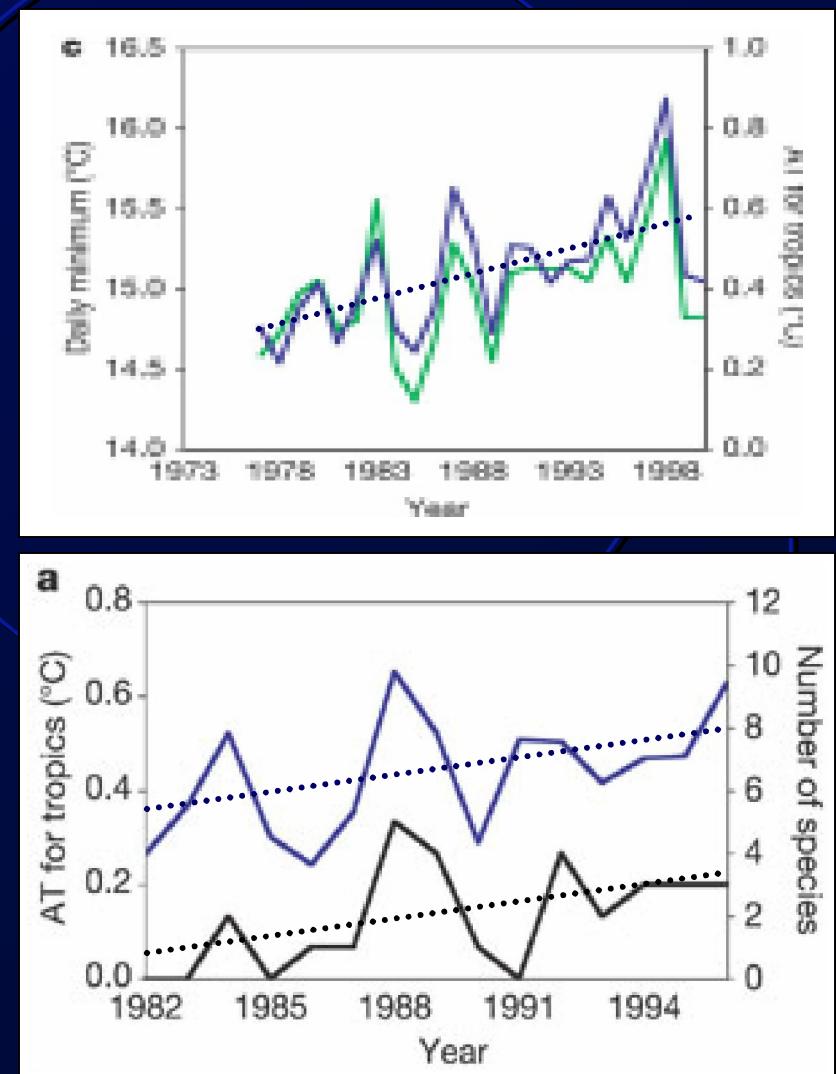
- + New results (March 2006)
  - Global warming  
No longer disputed
- + Largest detected warming trend (1.2 °F/decade)



Turner 2006, Science 311: 1914

# Attribution: Species Extinctions

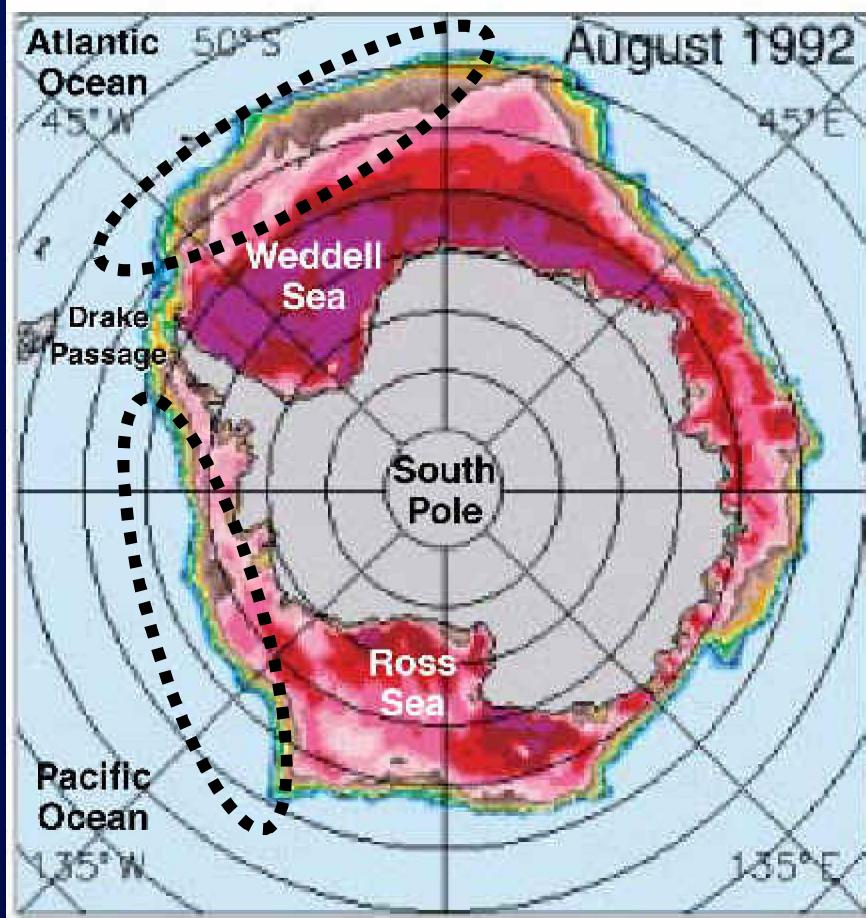
- Widespread mass amphibian extinctions related to fungal disease
- Timing and magnitude of extinction events provides fingerprint of climate change
- Climate pattern shown to relate to migration of the disease causing extinction



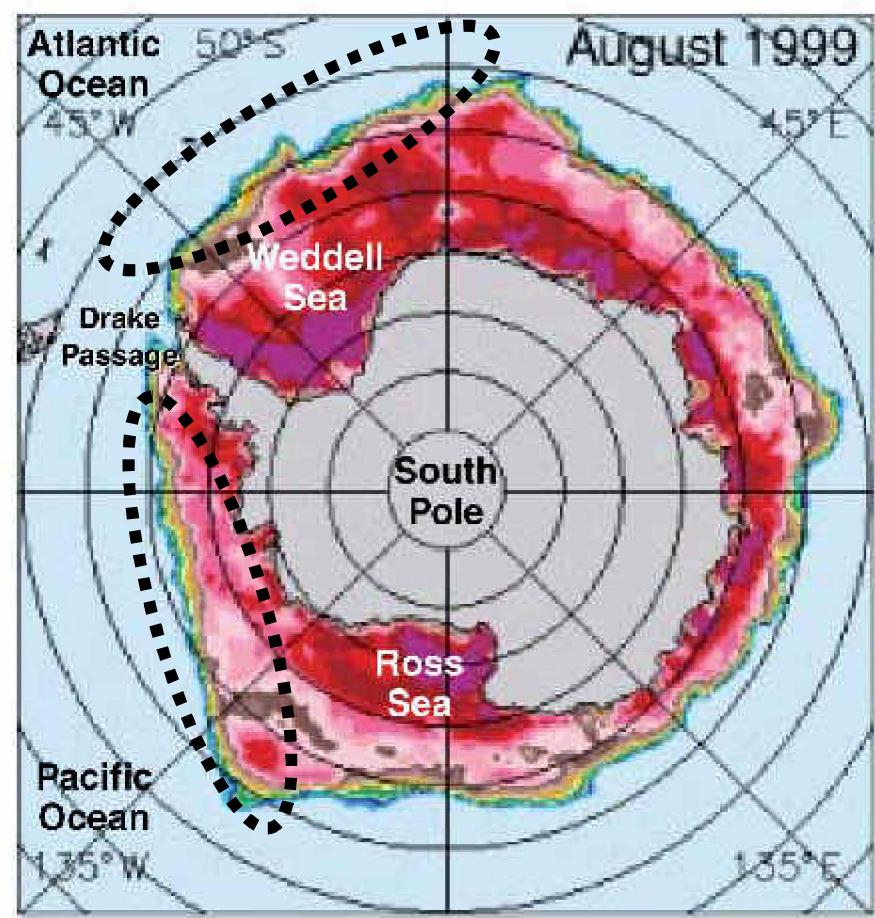
Pounds 2006, Nature 439:161

# Physical Laws: Internal Variability

ANTARCTICA  
1992 - El Niño Year

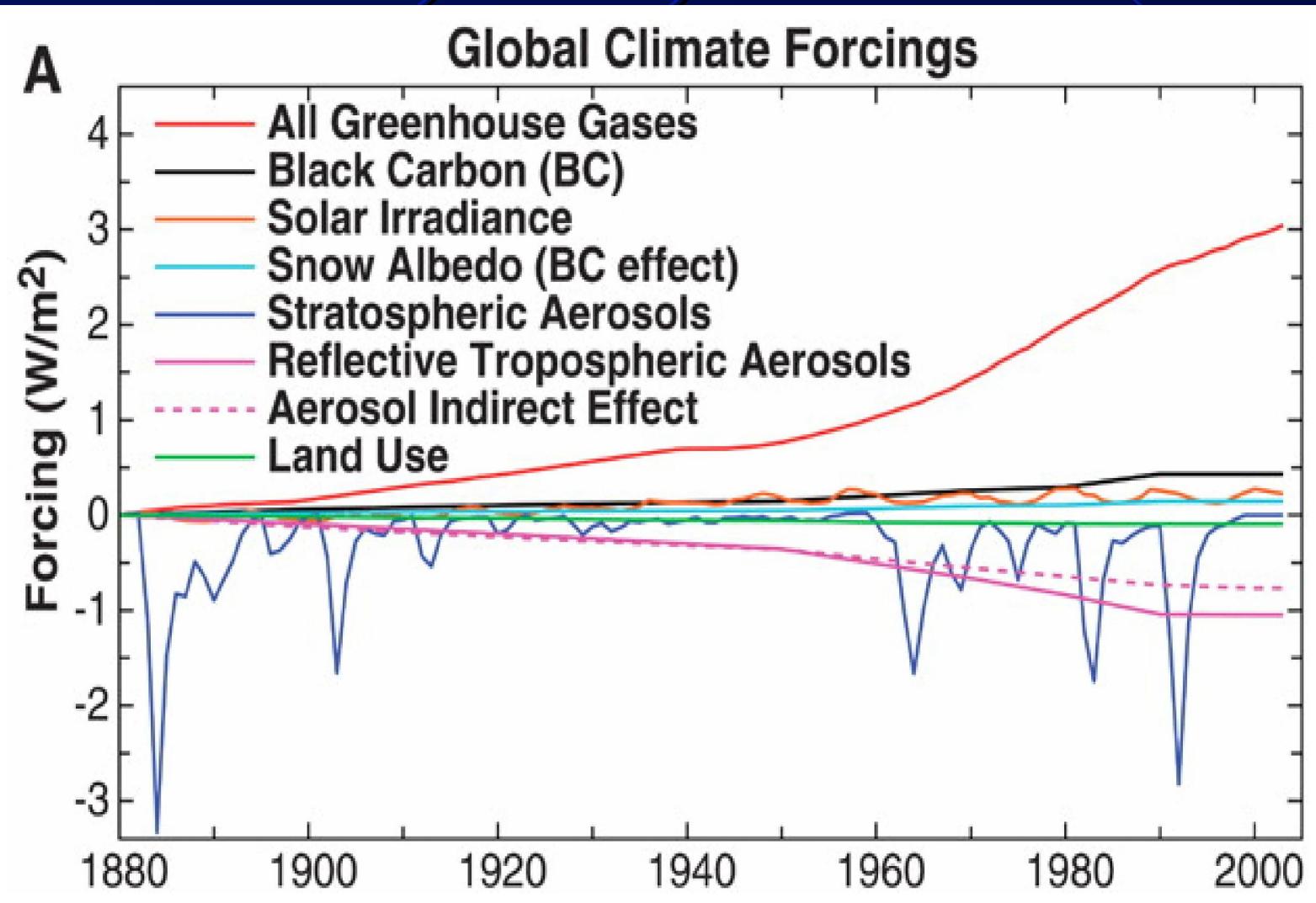


ANTARCTICA  
1999 - La Niña Year



Liu 2002, GRL 29: L015143

# Attribution – Physical Forcing



Hansen 2005, Science 308:1431